ENDEMIC INDEX OF MALARIA IN THE UNITED STATES.

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From morbidity and mortality records available, it is estimated that in 12 of the Southern States (Alabama, Arkansas, Georgia, Florida, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and the eastern part of Texas), having a total population of 25,000,000, at least 4 per cent of the population suffer an attack of malarial fever each year, and that 1 death occurs from this cause out of every 50 to 300 cases.

DEFINITIONS.

The term "endemic index" of malaria was first employed by Stephens and Christophers in June, 1900, to indicate the percentage of apparently healthy children whose blood, upon examination, showed malarial parasites present. In making comparative studies of splenic enlargements and of the presence of parasites in the blood, these investigators also showed that the splenic enlargement rate at the ages of 1 to 2 years is below, at 2 to 10 years slightly in excess of, and above 10 years usually in excess of, the malarial parasite rate found by blood examination.

Ross used the term "malaria index" or "endemic index" of a locality to mean "the percentage of persons in whom any evidence of malarial infection" is found; and the term "malarial rate," the "percentage of persons who contain plasmodia at some given moment."

Ross states that the number of parasites tends to vary inversely as the degree of splenic enlargement. This has been confirmed in a number of instances by investigators of the Public Health Service. In these cases, though the person was found to have a greatly enlarged spleen, due to chronic malaria, no parasites were found upon blood examination.

It was Prof. Koch, working in West Africa, who first reported in April, 1900, that apparently healthy children living in a malarious region frequently harbored the parasites of malaria in the blood, and that this fact might serve for determining the prevalence of malaria.

METHODS.

Three methods for ascertaining the malaria index of a place are quite generally in use by different authorities, namely:

1. Spleen rate.
2. Parasite rate.
3. The combined methods.

In any case, a statistical error is likely to occur in the course of random sampling, since such sampling does not include every person.

It is obviously impracticable to attempt to examine and have under control an entire population except in very small communities.

1. Spleen Rate.

This test depends upon the examination of persons by palpation (also by percussion) for enlarged spleens which are the result of chronic infections of malaria.

The method was first used by Dempster in India in 1845. It was found that this method could be applied in the examination of colored and foreign (chiefly Italian) races in only some sections of the United States, and it was not employed by the Public Health Service in its investigations. The white native of the United States and many negroes frequently resort to the use of "chill tonics" containing quinine and also to the use of quinine in the self treatment of "chills and fever." As a consequence, the chronic effects or sequelæ of malaria, with resultant enlarged spleens, are not so common, even where malaria is quite prevalent.

The advantages which have been claimed for the splenic method are:

1. Simplicity and quickness of application.
2. Applicability to the examination of large numbers of persons.

The following defects in the method have been met with:

1. Spleen may not be large in cases of early infections.
2. Spleen of healthy infants is often palpable.
3. Enlarged spleen may be due to other causes, such as kala-azar and tropical anemias (not common in the United States).
4. General use of quinine may interfere, by preventing enlargement of spleen, with value of enlarged spleen as an index.

2. The Parasite Rate.

This method is the one that has been used exclusively by the United States Public Health Service and for this reason it will be discussed in greater detail.

The first parasite rate (index) of malaria in the United States was made by Dr. B. B. Simms and Dr. B. B. Warswick, at Talladega, Ala., in September, 1907. In 610 examinations a rate of from 8 to 9 per cent was found.

In 1910 Dr. Hiram Byrd, assistant State health officer of Florida, collected 661 blood smears at 10 different places visited in the State. These were examined by the State board of health laboratories and showed 44 infections or 6.6 per cent.

The method depends on finding the parasites of malaria in the peripheral blood upon microscopic examination. It therefore requires considerable time and training of the examiner, and because of this only a limited number of examinations can ordinarily be made.

The conditions which influence its variation are:

(*a*) *Season.*—If taken at the beginning of the malarial season (March or April in the United States), just before the flight of anophelines, the findings will represent the very minimum percentage of carriers, because they exclude those persons who have recovered spontaneously or by treatment during the winter months. If taken at the end of the season, October or November, at the end of anopheline flight, the findings will give a larger percentage.

Whenever an index is used for comparative studies, as in places where antimalarial campaigns are in progress, it should be taken at the beginning and at the end of the season or at corresponding periods in the different years.

(*b*) *Ages.*—The index should be studied according to age periods. Children to the age of 10 years (possibly 15) best represent the native and more permanent population of a place.

In the United States it is important in establishing an index to examine adults as well as children, since among them is shown the frequency of carriers. A fair proportion of the population is also influenced by frequent change of residence from place to place.

(*c*) *Numbers.*—The percentage of error will naturally be smaller the greater the number examined and the lower the percentage of index.

Technique of Examination.

During the year 1913, one thick and one thin blood smear were made from each person examined, a total of 5,013; but during the years 1914 and 1915 only one thick blood smear was made from each person examined.

The thick film method in the examination of the blood for parasites was first used and described by Ross, 1903, and the technique of decolorizing and staining modified at different times by Ruge, L. Rogers, W. M. James, and others. This method is particularly well adapted to establishing a parasite rate or index. As an example, Technical Assistant H. A. Taylor made an examination of 526 thin blood smears corresponding to the thick blood smears in which parasites were found present. He was able to confirm the findings in but 125 or 23.7 per cent of the thin blood smears, although he employed one-half hour on the average for the examination of each thin blood film and five minutes for each thick blood film.

The method in obtaining blood, making blood smears, and staining as used by the Service is described in an article entitled "Malarial index work" in the Public Health Reports for December 26, 1913. Mention should be made of some modifications of this method suggested and employed by several of the workers engaged in these investigations. Assistant Epidemiologist T. H. D. Griffitts suggested

the use of phonograph needles (costing 5 cents per 100) for puncturing purposes, using a different needle for each individual. It was found by him quite practical and especially popular in handling school children who are being taught the ideas of asepsis and cleanliness.

The use of the broad end of a hardwood toothpick for spreading blood in making a thick blood smear, using a different stick for each smear, was found expeditious and very satisfactory.

A combination of the Ross and James methods in decolorizing blood smears was found by Technical Assistant H. A. Taylor to work satisfactorily, especially in the handling of smears which had been taken a month or more before examination.

The following is a full description of the different steps taken:

(*a*) Place slides in Coplin jar, arranged serially.

(*b*) Fill with water.

(*c*) After one or two minutes pour off water which has partly dissolved out the hemoglobin.

(*d*) Fill jar with 1 per cent hydrochloric acid solution in 70 per cent alcohol (ethyl alcohol).

(*e*) After complete decolorization, pour off the acid alcohol, which can be reused, and wash slides in running tap water one-half hour.

(*f*) After washing, pour on the stain. The original Giemsa stain is used, and is made up fresh from 0.1 per cent stock solutions, as follows:

	c. c.
0.1 per cent watery solution eosin, yellowish	10
0.1 per cent watery solution Azurii	10
Distilled or rain water	40

Staining will be accomplished in one-half to one hour. There is no danger of overstaining if allowed to remain much longer.

(*g*) After staining, rinse in water, dry, and examine.

A special study was made by Technical Assistant M. B. Mitzmain of an index taken in the vicinity of Scott, Miss., from residents on a number of plantations covering 40,000 acres.

Analyzing these findings, it is shown that of 492 in whom the parasites were found 122, or 24.8 per cent, showed gametocyte forms, and further that 32.8 per cent of the estivo-autumnal infections showed (crescent) gametocytes, whereas only 10.8 per cent of the tertian infection showed gametocyte forms. The prevalence of estivo-autumnal types to tertian types of infection was practically as 2 to 1.

The high index, 41.55 per cent, found in February and March, 1915, which is higher than the one taken and recorded in September, 1914 (showing 40.9 per cent), is due to the much longer time given to the examination of the thick blood smears than is usually employed, thereby finding a number of positives where parasites were extremely scanty.

The following gives a summary account of the special examinations made by Technical Assistant M. B. Mitzmain:

Vicinity of Scott, Miss.—Results of blood examinations, February and March, 1915.

Total persons examined	1,184
Positive for malaria	492
Parasite index.....per cent..	41.55
Omitting mixed cases and the one quartan, subtertian .....do....	64.4
Tertian.....do....	35.6
Number of gamete carriers	122
Subtertian with gametocytes	104
Tertian with gametocytes	18
Malarial cases with gametocytes .....per cent..	24.8
Cases of subtertian	317
Cases of tertian	166
Cases of quartan	1
Cases of mixed infection (excluded in the tertian and subtertian totals).....	8

The findings in 258 were scanty and would probably have been missed in thin smears.

It is of interest to note how closely the findings in the special studies, when compared as to the notation of gametocyte forms in our index records, agree with those of the routine examinations. It was found that these had been noted only in the estivo-autumnal findings. In a series of 8,234 examinations in which 865 tertian, 1 quartan, 494 estivo-autumnal, and 14 mixed infections were found, crescent or gamete forms were noted in 118, or 24 per cent of the 494 estivo-autumnal infections.

The accompanying tables give the number of examinations and findings, arranged by places, by States, and by ages.

SUMMARIES.

From these tables the following summaries may be made:

1. In a total of 13,526 blood examinations, 1,797, or 13.28 per cent showed parasites of malaria; that is, 1 of every 7.6 persons examined was found to be a carrier.

2. The percentage of infection among the whites was 8.08 per cent, and that among the colored 20.6 per cent.

3. The percentages by color and sex were as follows: White, male, 8.8 per cent; female, 7.1 per cent; colored, male, 21 per cent; female, 20 per cent.

4. The percentage of carriers was highest among those between 1 and 3 years of age, inclusive; lowest between 10 and 14 years.

The extremes of ages of persons found infected were 9 months and 85 years.

5. The tertian type of malaria prevails, the proportion being practically two cases of tertian to one of estivo-autumnal.

6. The quartan type is extremely rare; only two pure quartans and one mixed quartan and tertian were found in a total of 2,391 infections.

[Summaries continued on page 828.]

Blood examinations made from March, 1912, to Jnne, 1915, by places.

Place.	Year.	Number examined.					Number infected.				Types of infection.				Per-centage of infec-tions.
		White.		Colored.		Total.	White.		Colored.						
		M.	F.	M.	F.		M.	F.	M.	F.	T.	Q.	E.-A.	Mixed.	
Alabama:															
Mobile	1912	26	48	17	9	100	3	7	4	1	9	.....	6	.....	15.0
Do	1912	3	.....	28	15	46	1	.....	6	4	6	.....	5	.....	23.9
Plateau	1913	8	.....	79	25	112	.....	.....	2	.....	1	.....	1	.....	1.7
Talladega	1914	169	151	.....	.....	[1] 321	18	15	.....	.....	28	.....	5	.....	10.2
Clanton and vicinity	1914	205	142	28	25	[2] 412	36	32	4	5	55	.....	22	.....	18.7
Lock 12	1915	31	27	25	18	101	9	8	4	3	20	.....	4	.....	23.7
Leeds	1913	101	108	.....	.....	269	4	.....	.....	.....	4	.....	.....	.....	1.9
Montevallo	1913	3	193	.....	.....	196	.....	7	.....	.....	7	.....	.....	.....	3.5
Anniston	1913	120	13	14	.....	147	11	.....	3	.....	9	.....	5	.....	9.5
Arkansas:															
Augusta	1913	100	8	37	5	150	5	.....	2	.....	3	.....	4	.....	4.6
Lake Village	1913	152	41	88	42	323	8	1	5	3	14	.....	3	.....	5.2
Pine Bluff	1913	25	25	23	33	106	3	2	4	1	7	.....	3	.....	9.4
Scott	1913	9	6	40	47	102	1	1	3	4	4	.....	5	.....	8.8
Stuttgart	1913	50	15	46	10	121	2	2	4	2	7	.....	3	.....	8.2
Altheimer	1914	24	.....	34	25	83	3	.....	7	3	8	.....	2	3	15.6
Blissville	1914	79	28	135	125	[3] 370	7	3	29	15	21	.....	32	1	14.6
Blytheville	1914	147	6	71	46	270	11	.....	1	2	11	.....	3	.....	5.1
Brinkley	1914	156	28	100	29	[1] 314	17	6	8	3	20	.....	13	1	10.8
Crossett	1914	144	179	48	60	[4] 435	4	9	3	3	17	.....	2	.....	4.3
Cummins	1914	251	.....	581	25	[1] 858	66	.....	121	6	140	.....	53	.....	22.5
Helena	1914	110	61	163	192	526	2	6	21	19	36	.....	11	1	9.1
Little Rock	1914	54	22	31	19	126	4	1	3	3	8	.....	3	.....	8.7
Osceola	1914	87	13	75	83	258	4	1	9	3	15	.....	2	.....	6.5
Eldorado	1914	233	271	.....	.....	504	8	9	.....	.....	12	.....	5	.....	3.3
De Witt	1914	94	26	19	13	152	1	1	.....	1	2	.....	1	.....	1.9
North Carolina:															
Knott's Island	1913	251	264	.....	.....	515	9	6	.....	.....	12	.....	3	.....	2.9
Greenville	1913	137	338	20	31	526	9	20	5	2	32	.....	4	.....	6.8
Newberne	1913	125	126	87	169	507	4	2	13	29	35	.....	13	.....	9.4
Edenton	1913	177	191	.....	.....	368	26	20	.....	.....	34	.....	12	.....	12.5
Washington	1913	144	112	84	126	466	14	4	7	10	24	.....	11	.....	7.5
Rockingham	1913	9	9	1	.....	19	2	4	.....	.....	5	.....	.....	1	31.5
Elizabeth City	1913	207	194	184	224	[3] 812	18	9	[5] 17	23	58	.....	10	.....	8.3
Roanoke Rapids	1913	213	186	.....	1	400	34	21	.....	.....	40	.....	15	.....	13.7
Do	1914	419	347	3	11	780	13	22	.....	.....	28	1	5	1	4.4

Mississippi:															
Scott	1914	7	8	907	743	[1] 1,666	5	1	363	313	357	.....	319	6	40.9
Electric Mills	1914	114	77	164	172	527	15	6	25	16	53	.....	8	1	11.7
Do	1915	60	54	65	32	211	2	3	3	.....	7	.....	1	.....	3.8
South Carolina:															
Columbia	1913	10	4	24	29	67	1	.....	2	5	5	.....	3	.....	11.9
Virginia:															
Emporia	1914	147	171	2	.....	320	9	20	1	.....	27	.....	3	.....	9.4
Total	.....	4,401	3,492	3,223	2,384	13,500	389	249	[5] 679	479	1,181	1	600	15	.....

Histories incomplete or missing, 26; total, 13,526.
Total infected, 1,797, or 13.28 per cent.

[1] History incomplete or missing in 1 case.
[2] Histories incomplete or missing in 12 cases.
[3] Histories incomplete or missing in 3 cases.
[4] Histories incomplete or missing in 4 cases.
[5] One additional case, colored; age and sex not given.

Blood examinations made from February, 1915, to December, 1915, by places.

Place.	Year.	Number examined.				Total examined.	Number infected.				Types of infection.				Percentage of infections.
		White.		Colored.			White.		Colored.						
		M.	F.	M.	F.		M.	F.	M.	F.	T.	Q.	E.-A.	Mixed.	
Alabama:															
Lock 12	1915	30	27	8	9	74	2	6	.....	2	7	.....	3	.....	13.51
Mississippi:															
Scott and vicinity	1915	95	60	634	395	1,184	42	16	297	137	166	1	317	8	41.55
Lucedale	1915	77	81	29	26	213	4	4	2	2	8	.....	4	.....	5.63
Cedars	1915	17	6	90	6	119	3	.....	36	1	25	.....	12	3	33.6
North Carolina:															
Roanoke Rapids	1915	554	412	.....	.....	968	19	15	.....	.....	31	.....	3	.....	3.51
Do	1915	.....	.....	9	21	30	.....	.....	2	4	4	.....	2	.....	20.0
Total	.....	773	586	770	457	2,588	70	41	337	146	241	1	341	11	22.9

Summary, by States, of malaria index examinations made during the years 1912 to 1915.

State.	Number of places.	Year.	Number examined.		Total examined.	Number infected.		Types of infection.				Per cent.
			White.	Colored.		White.	Colored.	T.	Q.	E.-A.	Mixed.	
Alabama	7	1912–1915	1,348	283	1,631	151	36	139	.....	48	.....	11.4
Arkansas	16	1913–14	2,444	2,245	4,689	188	288	325	.....	145	6	10.1
North Carolina	8	1913–14	3,449	941	4,390	237	107	268	1	73	2	7.8
South Carolina	1	1913	14	53	67	1	7	5	.....	3	.....	11.9
Mississippi	2	1914–15	320	2,083	2,403	32	720	417	.....	328	[1] 7	31.2
Virginia	1	1914	318	2	320	29	1	27	.....	3	.....	9.3
Total	35	.....	7,893	5,607	13,500	638	1,159	1,181	1	600	15	.....

Histories incomplete, 26; total examined, 13,526.
Total infected, 1,797; 13.28 per cent.

SUPPLEMENTARY SUMMARY BY STATES.

Alabama	1	1915	57	17	74	8	2	7	.....	3	.....	13.5
Mississippi	3	1915	336	1,180	1,516	69	475	199	1	333	11	35.8
North Carolina	2	1915	[2] 966	30	998	34	6	35	.....	5	.....	4.0
Total	6	.....	1,359	1,227	2,588	111	483	241	1	341	11	22.9

Total examined, 2,588; infected, 594; 22.9 per cent.

[1] One tertian and quartan.

[2] Two additional cases; no record.

Malaria index examinations made in the States of Alabama, Arkansas, Mississippi, North Carolina, South Carolina, and Virginia from March, 1912, to June, 1915, by age of persons examined.

Age.	Number examined.					Number infected.				Types of infection.				Total infected.
	White.		Colored.		Total examined.	White.		Colored.[1]						
	M.	F.	M.	F.		M.	F.	M.	F.	T.	Q.	E.-A.	Mixed.	
Under 1 year	4	4	8	7	23	.....	.....	3	.....	2	.....	1	.....	3
1 to 3 years	49	48	62	50	209	6	2	20	13	22	.....	19	.....	41
4 to 5 years	50	52	91	104	297	10	8	21	16	40	.....	14	1	55
6 to 9 years	745	746	402	443	2,336	47	52	74	74	171	.....	72	4	247
10 to 14 years	1,274	1,154	569	587	3,584	99	84	93	92	271	.....	94	3	368
15 to 19 years	576	844	368	318	2,106	49	55	74	57	161	.....	72	2	235
20 to 29 years	656	307	752	424	2,139	80	17	159	100	220	1	133	2	356
30 to 39 years	474	145	417	195	1,231	45	13	96	54	126	.....	82	.....	208
40 years and over	548	108	545	249	1,450	47	9	136	71	152	.....	108	3	263
Not stated	25	84	9	7	125	6	9	3	2	16	.....	5	.....	21
Total	4,401	3,492	3,223	2,384	13,500	389	249	679	479	1,181	1	600	15	1,797

Histories missing or incomplete, 26: total number examined, 13,526.
Total infected, 1,797; percentage of infection, 13.28 per cent.

SUPPLEMENTARY SUMMARY BY AGES.

1 to 3 years	11	7	12	13	43	8	1	.....	7	7	.....	9	.....	16
4 to 5 years	11	10	19	14	54	2	2	5	5	6	.....	7	1	14
6 to 9 years	113	121	40	56	330	4	6	22	12	25	1	17	1	44
10 to 14 years	153	177	93	72	495	9	6	44	24	25	.....	57	1	83
15 to 19 years	103	110	112	52	377	6	8	52	22	34	.....	52	2	88
20 to 29 years	165	92	181	113	551	21	7	93	44	78	.....	84	3	165
30 to 39 years	128	42	132	51	353	12	6	45	18	27	.....	53	1	81
40 years and over	84	22	179	86	371	8	5	76	14	39	.....	62	2	103
Not stated	5	5	2	.....	12	.....	.....	.....	.....	.....	.....	.....	.....	.....
No record	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	773	586	770	457	2,588	70	41	337	146	241	1	341	11	594

[1] One additional case, colored; age and sex not given.

7. Mississippi showed the highest percentage of infection, 31.2 per cent, while North Carolina showed the lowest (7.8 per cent) in these studies.

8. The percentages of infection according to places varied from 1.7 per cent (Plateau, Ala.) to 40.9 per cent (for Yazoo Valley, Miss.).

9. In establishing an index in the United States for comparative and economic studies, the examination should include adults as well as children; in other words, a representative index must include all age groups.

10. It is estimated that 1 of 4 infected persons harbors the sexual forms (gametocyte) necessary for infecting a malaria bearing mosquito. This would give an average of 1 person in every 32 (of the 13,526 examined) to be potential malaria carriers at all times.

PLAGUE-PREVENTION WORK.

CALIFORNIA.

The following report of plague-prevention work in California for the week ended March 11, 1916, was received from Surg. Boggess, of the United States Public Health Service, in charge of the work:

SAN FRANCISCO, CAL.

RAT PROOFING.

New buildings:	
Inspections of work under construction	151
Basements concreted (square feet, 18,640)	19
Floors concreted (square feet, 29,050)	15
Yards, passageways, etc. (square feet, 13,183)	30
Total area of concrete laid (square feet)	60,873
Class A, B, and C (fireproof) buildings:	
Inspections made	151
Roof and basement ventilators, etc., screened	1,060
Wire screening used (square feet)	4,860
Openings around pipes, etc., closed with cement	1,970
Sidewalk lens lights replaced	200
Old buildings:	
Inspections made	499
Wooden floors removed	35
Yards and passageways, planking removed	16
Cubic feet new foundation walls installed	7,770
Concrete floors installed (square feet, 27,070)	37
Basements concreted (square feet, 26,050)	35
Yards and passageways, etc., concreted (square feet, 24,643)	84
Total area concrete laid (square feet)	77,763
Floors rat proofed with wire cloth (square feet, 2,400)	2
Buildings razed	20

SAN FRANCISCO, CAL.—Continued.

RAT PROOFING—continued.

New garbage cans stamped approved	575
Nuisances abated	299

OPERATIONS ON THE WATER FRONT.

Vessels inspected for rat guards	21
Reinspections made on vessels	30
New rat guards procured	6
Defective rat guards repaired	11
Rats trapped on wharves and water front	28
Rats trapped on vessels	34
Traps set on wharves and water front	175
Traps set on vessels	53
Vessels trapped on	11
Poisons placed on water front (pieces)	3,600
Poisons placed within Panama-Pacific International Exposition grounds	41,000
Bait used on water front and vessels, bacon (pounds)	6
Bread used in poisoning water front (loaves)	9
Poison used on water front (pounds)	3

RATS COLLECTED AND EXAMINED FOR PLAGUE.

Collected	412
Examined	345
Found infected	None.

RATS IDENTIFIED.

Mus norvegicus	193
Mus rattus	69
Mus alexandrinus	101
Mus musculus	49